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Evaluation of a 9th-Grade Integrated STEM Curriculum Connecting Biology, Data Analysis with Excel, and Problem-Solving (Evaluation)

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Abstract

The BSEE curriculum integrates biology (science), Excel skills (technology), data analysis (mathematics), and problem-solving (engineering) within a 9th-grade integrated STEM framework. We implemented the curriculum in a high school elective course, Introduction to Computer Science. Students analyzed local deer mortality data and applied Excel functions to identify trends. They created data visualizations to address real-world challenges. Such an interdisciplinary approach connects STEM fields and bridges the gap between scientific knowledge, technological tools, and practical problem-solving skills. We evaluated the BSEE curriculum using teachers' self-assessments and peer evaluations. The evaluations used edTPA and iSTEM rubrics to assess the implementation, student engagement, and alignment with integrated STEM principles. The evaluation examined the clarity of instructional materials, the feasibility of technology integration, and areas for improvement. Our study evaluates the BSEE curriculum and ultimately sheds light on the strengths and challenges of interdisciplinary STEM education. It provides recommendations for improving curriculum design and implementation. This paper contributes to the pre-college engineering education community by providing a comprehensive evaluation of the BSEE curriculum, detailing its implementation, and presenting evidence and data-related results to contribute to the discourse on integrated STEM education.

Research Background

iSTEM rubric

Integrated STEM (iSTEM) education is a transformative pedagogical approach designed to equip students with the interdisciplinary skills necessary to address 21st-century challenges (Moore et al., 2021). By bridging the traditionally separate disciplines of science, technology, engineering, and mathematics, iSTEM education promotes critical thinking, problem-solving, and the ability to connect theoretical concepts with real-world applications (Stohlmann et al., 2012). Despite its potential, iSTEM education faces significant challenges in implementation. Such challenges include aligning the new iSTEM curriculum with well-established standards such as the CCSSM and NGSS and addressing the shortage of teachers proficient in multiple STEM disciplines. This paper aims to explore and solve such challenges by developing a new iSTEM curriculum, namely, the BSEE curriculum, that connects Biology, Statistics, Excel skills, and Engineering. In this paper, we provide a comprehensive evaluation of the BSEE curriculum by detailing its implementation and presenting robust evidence and data-related results to contribute to the discourse on integrated STEM education. Considering this paper's primary focus, i.e., the evaluation, the following two paragraphs briefly describe two sets of rubrics (i.e., iSTEM rubric and edTPA rubric) that we used to evaluate our new curriculum.

The iSTEM rubric serves as a framework for evaluating the effectiveness of integrated STEM education practices across various dimensions. It offers a structured approach to assessing the extent to which learning experiences align with key objectives in STEM education (National Academy of Engineering and National Research Council, 2014). The rubric provides educators with actionable criteria to design and assess STEM curricula that are explicit, developmentally appropriate, and differentiated to meet diverse learner needs.

- Rubric 1. STEM Literacy: STEM literacy emphasizes the integration of two or more STEM disciplines to foster an understanding of their roles in modern society and fundamental concepts.
- Rubric 2. 21st Century Competencies: Fostering 21st-century competencies involves the development of cognitive, interpersonal, and intrapersonal skills.
- Rubric 3. STEM Workforce Readiness: Increasing student awareness of STEM career opportunities and pathways to further education.
- Rubric 4. STEM Interest, Engagement, and Identity: Cultivating STEM interest and identity requires culturally relevant, open-ended, and localized learning experiences that allow students to be recognized as experts.
- Rubric 5. Ability to Make STEM Connections: Recognizing interdisciplinary applications of concepts, engaging in practices that draw on knowledge from multiple disciplines, and understanding when and how to apply STEM knowledge.

Bauer (2023) used this iSTEM rubric to analyze pre-service teachers' (PSTs) conceptualization of trans- and interdisciplinary approaches to STEM education. More specifically, the rubric was used to evaluate integrated STEM projects designed by pre-service teachers. The rubric's components are used to assign ratings to each project and to assess the degree of perceived connections and integration of STEM disciplines. The analysis includes examining how the pre-service teachers align their projects with grade band or level content standards, specifically with the Common Core State Standards for Mathematics (CCSSM) and Next Generation Science Standards (NGSS). The study suggests that the iSTEM rubric is a valuable tool for evaluating the integration of STEM disciplines in educational projects. It helps educators understand how well projects incorporate critical thinking, collaboration, and STEM connections. The rubric also guides teachers in aligning their projects with educational standards and in ensuring that they meet curriculum requirements.

edTPA rubric

The edTPA (Educative Teacher Performance Assessment) is a comprehensive, performance-based assessment designed to evaluate the readiness of novice teachers, particularly in technology and engineering education (Stanford Center for Assessment, Learning, and Equity (SCALE), 2021). Rooted in research and feedback from educators, the edTPA emphasizes a reflective teaching cycle, encompassing planning, instruction, and assessment.

- Planning (Rubrics 1-5): Teachers must design lessons that support diverse student needs while integrating technology-related concepts, technical skills, and engineering practices. This planning process includes anticipating preconceptions and addressing language demands, such as technical vocabulary and syntax, which are crucial for STEM education.
- Instruction (Rubrics 6-10): These rubrics evaluate how teachers create a safe, engaging learning environment and scaffold student understanding of complex concepts. A significant focus is placed on eliciting student responses that deepen their learning and encourage collaborative problem-solving.

- Assessment (Rubrics 11-15): Teachers are required to analyze student work for patterns of learning, provide targeted feedback, and use this analysis to inform future instruction. These tasks promote data-driven decision-making, a core element of STEM education.

Moon et al. (2021) utilized the edTPA rubrics as a standardized-performance-based, subject-specific assessment tool to evaluate preservice secondary science and mathematics teachers' readiness and performance. The study aimed to determine the correlation between teacher readiness, as measured by a post-survey, and the edTPA scores, which are crucial for teacher certification in many U.S. states, including California. The researchers collected edTPA scores at the end of the teacher education programs to assess the effectiveness of these programs in preparing teachers for real-world classroom challenges. The usefulness of the edTPA rubrics in this study is highlighted by their role in providing a structured and objective measure of teacher candidates' abilities across critical teaching dimensions. Despite the lack of significant correlation found between teacher readiness and edTPA scores, the rubrics offer a comprehensive framework for evaluating essential teaching competencies, such as planning and implementing standards-based instruction and addressing language and literacy needs of multilingual learners.

Similarly, Goldhaber et al. (2017) employed the edTPA rubrics to assess the predictive validity of teacher candidates' performance on the edTPA in relation to their future employment and effectiveness in the teaching workforce. The study utilized data from Washington State, where the edTPA is a requirement for teacher licensure, to analyze the relationship between edTPA scores and subsequent teaching effectiveness, measured through value-added models of student achievement. The edTPA rubrics, which cover planning, instruction, and assessment, were used to generate a summative score for each candidate, providing a standardized measure of their teaching capabilities. The edTPA rubrics proved useful in this study by serving as a high-stakes screening tool that predicts the likelihood of teacher candidates entering the workforce and their potential effectiveness in the classroom. The rubrics offer a detailed evaluation of candidates' teaching practices, which can inform hiring decisions and support the development of teacher education programs.

Development of the BSEE curriculum

Collectively, we refer to our new curriculum as the BSEE curriculum, representing Biology, Statistics, Excel, and Engineering—the core fields integrated into the lessons. We developed the BSEE curriculum as part of a graduate course designed to apply the integrated STEM framework in secondary education. Our team consisted of one undergraduate student majoring in Technology and Engineering Education and three graduate students specializing in Mathematics Education, Technology Education, and Engineering Education. Collaborating with a local high school technology teacher, we ensured the curriculum aligned with practical classroom settings and addressed real-world STEM applications.

As the central theme of the BSEE curriculum, we chose deer mortality data due to its local relevance to XYZ County and its alignment with the cultural and environmental emphasis in the edTPA rubrics. Each team member designed a lesson based on their expertise while keeping the four lessons all centering around the deer mortality data. We structured the lessons to build upon each other to create a cohesive curriculum. Lesson 1 introduced foundational biology concepts, while Lesson 2 covered basic Excel skills and statistical analysis. Lesson 3 advanced to data visualization, and Lesson 4 engaged students in proposing engineering solutions to real-world challenges like reducing deer-vehicle collisions.

To refine our lessons, we piloted the curriculum in our graduate course. Peers acted as students by engaging in the activities and providing constructive feedback. We then revised the lessons using self-assessments and peer evaluations guided by the iSTEM and edTPA rubrics. Such rubrics helped us enhance clarity, strengthen interdisciplinary connections, and improve student engagement.

Our curriculum design is supported by literature emphasizing the importance of real-world relevance in STEM education. Berland and Steingut (2016) demonstrated how the practical value of math and science enhances student engagement. Thibaut et al. (2018) identify integration of STEM content, problem-centered learning, inquiry-based learning, design-based learning, and cooperative learning as key components of effective STEM instruction. To embody such principles, our curriculum leveraged data to ground problem-solving, support inquiry, and foster collaboration. In addition, we emphasized iterative learning and interdisciplinary connections. This approach aligns with Berland and Steingut's (2016) recommendation to balance product design with the learning process, equipping students with both technical skills and an appreciation for real-world STEM applications.

Description of the BSEE curriculum

Overview and purpose

Lesson 1 introduces students to the key biological and mathematical concepts surrounding deer population dynamics in XYZ County. Using real-world data on deer mortality due to hunting, harvesting, and vehicle collisions, students will analyze the impact of such factors on population fluctuations. Lesson 1 is the foundation for the following lessons, in which each student group will take on a specific career perspective, such as insurance company staff, farmer, hunter, and biologist. Each lesson builds upon the previous one, guiding students through a comprehensive exploration of data analysis and problem-solving techniques.

Lesson 2 introduces students to the fundamentals of descriptive statistics and data analysis through the lens of deer mortality dynamics. Students will calculate these statistics to make career-based interpretations that inform wildlife management and public safety decisions, such as reducing deer-vehicle collisions, managing population control, and supporting ecosystem balance.

Lesson 3 will show students good and bad practices in data visualization and a tutorial on how to visualize data in Excel. Using the knowledge gained from this activity, students will work through a design process to create a visualization of their own to experience how graphs and charts can be used for the purposes of various careers.

Lesson 4 is the final stage in a four-part series on data analysis, focusing on constructing data-driven arguments from different professional perspectives. Students will use previously analyzed and visualized data to develop arguments for or against different strategies to manage deer populations, including potential impacts on local ecology and public safety.

Alignment with STEM curriculum standards

The BSEE curriculum aligns with a range of science, mathematics, technology, and engineering standards offered by XYZ state where the curriculum was implemented. These alignments were to ensure that students engage with foundational STEM concepts while applying their knowledge to real-world scenarios. The standard codes offered by the state Department of Education will be added in the final version of this manuscript to follow the anonymous policy.

Lesson 1 integrates foundational biological and mathematical concepts to explore deer population dynamics and human impacts.

Science standards:

- Use mathematical and/or computational representations to support explanations of factors that affect the carrying capacity of ecosystems at different scales.
- Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Mathematics standards:

- Define appropriate quantities for the purpose of descriptive modeling.

Lesson 2 focuses on mathematical analysis and Excel proficiency and aligns with the following standards.

Mathematics process standards:

- Reason abstractly and quantitatively.
- Use appropriate tools strategically.

Mathematics content standards:

- Compute and use mean, median, mode, weighted mean, geometric mean, harmonic mean, range, quartiles, variance, and standard deviation.
- Understand and communicate percentages as rates per 100, and identify uses and misuses of percentages related to a proper understanding of the base in real-world and mathematical problems.

Technology standards:

- Use technology to gather, evaluate, and/or use data for analysis and problem-solving.

Lesson 3 emphasizes advanced Excel functions for data visualization, aligning with the following standards.

Mathematics content standards:

- Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
- Summarize numerical data sets in relation to their context.

Technology standards:

- Use technology to gather, evaluate, and/or use data for analysis and problem-solving.
- Plan and employ effective research.

Lesson 4 integrates concepts from science and engineering to develop practical solutions to wildlife management challenges.

Science standards:

- Use mathematical and/or computational representations to support explanations of factors that affect the carrying capacity of ecosystems at different scales.
- Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Engineering standards:

- Identify engineering and technology occupations and the roles and responsibilities of each.
- Discuss historical and current events related to engineering and technology and analyze their impact on society.

Implementation of the BSEE curriculum

Each lesson in the BSEE curriculum lasted 45 minutes, considering that one class period in the participating school was 95 minutes. Lessons 1 and 2 were implemented by Members 1 and 2, respectively, on the first day, while Lessons 3 and 4 were delivered by Members 3 and 4 on the second day. The curriculum was implemented in a 9th-grade introductory computer science (CS) course, with a total of 28 students participating. This course is an elective designed to introduce students to the fundamentals of computing, including hardware and software concepts, basic Python programming, and an exploration of computing careers. The course also addresses current issues in computing and provides students with foundational skills in text-based programming.

The table in Appendix 1 presents the detailed plan for the entire BSEE curriculum. While each team member adhered to a consistent format, minor variations were incorporated to reflect individual lesson plan styles. Such variations were allowed to represent each member's unique perspectives and expertise while maintaining cohesion across the four lessons.

Evaluation of the BSEE curriculum

Before implementation: self-evaluation and peer evaluation

Prior to implementing the BSEE curriculum at the local high school, we conducted self and peer evaluations to refine our lesson plans. Such evaluation process utilized five iSTEM rubrics and five edTPA rubrics to assess the quality and effectiveness of our lessons. The rubrics included: iSTEM rubrics (1. STEM Literacy, 2. 21st Century, 3. STEM Workforce Readiness, 4. STEM Interests, Engagement, and Identity, 5. Ability to Make STEM Connections, edTPA rubrics (6. Learning Environment, 7. Engaging Students in Learning, 8. Deepening Student Learning, 9. Subject-Specific Pedagogy: The Work Artifact(s), 10. Analyzing Teaching Effectiveness).

During the practice lesson delivery, we video-recorded ourselves for comprehensive self and peer evaluations. The evaluation template, shown in Table 2, consisted of fixed prompts (bold and italicized) to which we provided structured responses (plain text).

Table 2. A part of the template of self and peer evaluatio

Rubric: ISTEM: 4. STEM Interests, Engagement and Identity (Delivering)
Self/peer assessed score level: (Example) 5
Description of that level: (Example) Are the learning experiences: Open-ended; Culturally relevant; Situated in a localized context; Providing the opportunity for students to be recognized as experts; Explicit, developmentally appropriate cross-cutting, and differentiated based on the needs of individuals and groups.
Rationale (one-two paragraph(s), based on evidence marked in GoReact on the video): What was done to earn that level? What could you do next time to reach a higher level (or do better if highest level)? (Example) The candidate effectively fostered STEM interest, engagement, and identity by creating a learning experience that was open-ended, culturally relevant, and locally grounded. She linked the lesson to students' own environments (i.e., deer mortality data of XYZ County) and asked open-ended questions to encourage them to draw from personal experiences. Such instructions made the learning experience meaningful and relatable. Additionally, the candidate incorporated culturally relevant examples tied to students' chosen professional roles (i.e., farmer, insurance company, and hunter). Such an incorporation allowed them to see how STEM concepts apply within various cultural and local contexts. To further enhance her instructional strategy, the candidate could provide students with more opportunities to showcase their expertise by facilitating peer presentations or discussions where they share their findings and perspectives.

Given the space limitations, only the scores are included in this manuscript. Table 3 summarizes the peer evaluation scores, while Table 4 presents the self-evaluation scores.

Table 3. Peer evaluation scores

Evaluated Member	iSTEM rubrics					edTPA rubrics				
	1	2	3	4	5	6	7	8	9	10
1	3	5	5	5	3	5	5	5	4	4
2	5	5	5	5	4	4	4	5	4	4
3	4	3	3	3	3	4	3	3	3	3
4	4	4	4	5	4	4	4	5	4	3

Table 4. Self-evaluation scores

Evaluated Member	iSTEM rubrics					edTPA rubrics				
	1	2	3	4	5	6	7	8	9	10
1	5	5	4	5	5	4	4	4	4	3
2	5	5	5	5	5	5	5	5	4	4
3	4	4	4	5	4	4	4	4	4	3
4	4	4	4	3	3	4	4	4	4	3

After implementation: in-depth self-evaluation

Following the curriculum implementation, we conducted an in-depth self-evaluation by reviewing video recordings of our teaching. The recorded videos did not include students and focused solely on the lesson delivery. Such post-implementation evaluation expanded upon the initial evaluations by incorporating a more comprehensive analysis of our teaching practices.

We wrote three edTPA commentaries: planning commentary, instruction commentary, and assessment commentary. Then, using such detailed reflections, we evaluated our teaching against five iSTEM rubrics and an extended set of eight edTPA rubrics. In addition to the rubrics used during the pre-implementation evaluations, the post-implementation evaluations included the following new edTPA rubrics: 11. Analysis of Student Learning, 12. Providing Feedback to Guide Learning, 15. Using Assessment to Inform Instruction.

The updated self-evaluation template, shown in Table 5, was tailored to include such additional rubrics and provide a structured format for in-depth analysis. Table 6 summarizes the self-evaluation scores.

Table 5. A Part of the Template for Post-Implementation Self-Evaluation

Rubric: edTPA: 11. Analysis of Student Learning
Self/peer assessed score level: (Example) Level 4
Description of that level (copy/paste from Brightspace): (Example) Analysis uses specific examples from work samples to demonstrate patterns of learning consistent with the summary. AND Patterns of learning are described for whole class.
Rationale (one-two paragraph(s), based on evidence in the work samples and assessment commentary): What was done to earn that level? What wasn't done to justify the next level? (Example) To earn Level 4, I provided specific examples from student work samples to demonstrate patterns of learning across the class. For instance, I analyzed how students engaged with calculations of deer harvest and their ability to justify predictions using data trends. The hunter group showed higher engagement and accuracy in applying mathematical formulas, while the biologist group needed more guidance to address all variables. Additionally, I described patterns of learning for the whole class, such as the general difficulty in translating verbal observations into written responses and the need for scaffolding to support data analysis. These observations were consistent with the summary provided in the assessment commentary. To justify Level 5, I would need to explicitly connect the quantitative and qualitative patterns of learning for individuals or groups, such as linking specific numerical outcomes (e.g., accuracy in percentage calculations) to broader qualitative trends (e.g., critical thinking in ecological impact discussions). Incorporating such connections would allow students to provide a deeper and more comprehensive analysis of individual and group learning. Additionally, I could include more targeted examples to show how individual student learning outcomes reflect broader trends in class dynamics.

Table 6. Self-evaluation scores

Evaluated Member	iSTEM rubrics					edTPA rubrics							
	1	2	3	4	5	6	7	8	9	10	11	12	15
1	5	5	3	5	5	5	4	4	4	4	4	4	4
2	5	5	5	4	5	5	5	5	4	4	5	4	4
3	4	4	4	5	4	4	4	4	4	3	4	3	3
4	4	4	4	3	4	5	4	4	4	3	3	3	3

Discussion

For each rubric, we summarized our self-reflections and discussed the important findings regarding the evaluation of developing and implementing the BSEE curriculum.

iSTEM rubric #1 STEM Literacy

The self-reflections of the four members revealed a shared emphasis on fostering STEM literacy by connecting interdisciplinary STEM areas to real-world applications. All members prioritized helping students understand the relevance of STEM roles in modern society, particularly through the integration of mathematics, technology, and data analysis. They consistently engaged students in exploring how STEM concepts apply to career-specific contexts, such as farming, insurance, and wildlife management. The members also encouraged discussions to reinforce the connection between STEM skills and professional practices.

iSTEM rubric #2 21st Century Competency

The reflections across all four members showed both successes and areas for improvement in fostering 21st-century competencies. All members effectively promoted cognitive development by engaging students in critical thinking tasks, such as analyzing deer mortality data, constructing arguments, and creating visualizations tailored to professional roles. Interpersonal skills were cultivated through collaborative group activities. However, members acknowledged the need to facilitate equitable participation and group dynamics. For example, while students actively engaged in discussions, some groups did not fully represent all members' opinions or contributions. Additionally, we admitted a need to encourage students to take on leadership roles or to emphasize deeper connections between their findings and broader implications.

iSTEM rubric #3 STEM Workforce Readiness

The reflections indicate a collective effort to promote STEM workforce readiness by assigning groups roles that align with real-world professions, such as insurance agents, farmers, hunters, and biologists. Such activities helped students connect their classroom learning to the professional tasks involved in data analysis, pattern detection, and decision-making. However, a shared limitation across the reflections was the lack of explicit discussions about career pathways and further education opportunities. Suggestions for improvement included integrating multimedia resources, such as videos or interviews with STEM professionals, and incorporating activities where students explore the educational qualifications required for different careers. Additionally, members noted the need for more practical, hands-on activities to provide students with a deeper understanding of how STEM skills are applied in workforce settings.

iSTEM rubric #4 STEM Interests, Engagement and Identity

The reflections shared consistent efforts to foster STEM interest, engagement, and identity through localized and culturally relevant contexts. All members emphasized the importance of using real-world data from XYZ County, which helped students connect the lessons to their community and made the learning experience meaningful. Assigning professional roles to each student group allowed students to explore STEM concepts from diverse perspectives and consider real-world implications. Open-ended questions were widely used to encourage critical thinking and engagement. However, there was a shared recognition that the lessons could have done more to provide opportunities for students to be recognized as experts. Suggestions for improvement included having students present their findings to external audiences or incorporating additional culturally diverse examples to broaden students' understanding of STEM's societal relevance.

iSTEM rubric #5 Ability to Make STEM Connections

All members make consistent efforts to integrate STEM disciplines and help students recognize connections across biology, mathematics, technology, and engineering. We emphasized the use of Excel as a technological tool to analyze deer mortality data, which linked mathematical concepts like range and median with scientific reasoning for wildlife management. Lessons also aimed to connect prior content, such as transitioning from biology to mathematical calculations and introducing engineering-oriented thinking through data-driven decision-making. However, we acknowledged areas for improvement, including incorporating explicit engineering practices earlier in the lesson sequence and ensuring coherent integration of STEM elements. Suggestions included encouraging students to propose solutions based on their data analysis and tailoring STEM connections to meet diverse student needs.

edTPA rubric #6 Learning Environment

All members prioritized creating a respectful and supportive learning environment by focusing on student engagement and collaboration. We emphasized clear communication of learning objectives, active encouragement, and personalized support for students who struggled to focus or participate. Techniques like open-ended questions, group work based on career roles, and humor helped build rapport and foster inclusivity. We also encouraged critical thinking by introducing new tasks, such as graph creation, and ensured a safe space for students to share ideas, regardless of accuracy. However, we noted areas for improvement. Such areas include providing more structured opportunities for peer interaction, encouraging diverse perspectives, and promoting deeper dialogue.

edTPA rubric #7 Engaging Students in Learning

All members successfully engaged students in learning by connecting lesson objectives to prior knowledge, local contexts, and relevant career roles. We linked concepts such as deer mortality in XYZ County and statistical reasoning to students' existing understanding. Activities such as Think-Pair-Share, graph creation, and argumentation allowed students to actively participate and develop both technical and conceptual skills. We also used open-ended questions and group discussions to encourage critical thinking and evidence-based reasoning. However, we identified areas for improvement, such as incorporating prior statistics into new tasks, managing time more effectively, and challenging students to evaluate alternative perspectives.

edTPA rubric #8 Deepening Student Learning

The reflections reveal that all members aimed to deepen student learning by fostering connections between scientific concepts, data analysis, and evidence-based reasoning. Members used structured activities, including open-ended questions, collaborative group work, and guided use of Excel, to encourage higher-order thinking and detailed student responses. Prompts to explain reasoning and opportunities for peer discussion helped students refine their understanding. However, members identified areas for improvement, such as incorporating peer-assessment activities to enhance critical thinking, facilitating more cross-group discussions to broaden perspectives, and dedicating more time to technological concepts to strengthen students' proficiency with tools like Excel. These strategies would further enrich the depth of student learning in future implementations.

edTPA rubric #9 Subject-Specific Pedagogy: The Work Artifact(s)

All members utilized structured work artifacts, such as handouts, worksheets, and student-created slides or graphs, to support data analysis and connect students' findings to broader contexts. We encouraged students to document their reasoning and share their work. This was to facilitate deeper engagement with the material and critical thinking about patterns and inconsistencies in the data. We also guided students to consider data limitations and potential applications of their work artifacts in real-world or career-specific scenarios. However, areas for improvement included incorporating a variety of representations, such as additional graphs and charts, and providing clearer connections to the professional relevance of the work artifacts.

edTPA rubric #10 Analyzing Teaching Effectiveness

We actively analyzed our teaching effectiveness and made real-time adjustments to address students' needs and classroom challenges. Common strategies included modifying lesson pacing, adjusting classroom management approaches, and encouraging collaboration among students to ensure collective engagement. We demonstrated responsiveness by addressing disengaged students through targeted questions, pairing unprepared students with others, or reallocating time to focus on critical activities. However, areas for improvement were consistently identified. For instance, we had better justify instructional changes using explicit connections to research or theory, such as sociocultural learning theory or scaffolding strategies. Additionally, some members noted challenges in fully engaging all students or facilitating deeper discussions. In the future, further exploration of students' behaviors and preferences seems to be required to refine teaching practices.

edTPA rubric #11 Analysis of Student Learning

We consistently identified quantitative outcomes, such as students' ability to calculate statistical measures, create graphs, or apply formulas, as well as qualitative outcomes, such as the interpretation of data within the context of their assigned professions. However, a common challenge was the need to explicitly connect such quantitative and qualitative observations to provide a more comprehensive analysis of learning. We also noted patterns of varying proficiency across groups, such as the stronger engagement and performance of the hunter and farmer groups compared to other roles. We acknowledged the potential to incorporate more targeted evidence from student work and to explicitly link individual outcomes to broader class trends.

edTPA rubric #12 Providing Feedback to Guide Learning

The reflections indicated a collective effort to provide specific feedback addressing students' strengths and areas for improvement. However, a common theme was the need for feedback to be more actionable, with explicit opportunities for students to use the guidance provided to enhance their learning. For example, we all noted missed opportunities to offer strategies or suggestions for deeper exploration and connections to prior learning. Some reflections also acknowledged the challenge of balancing detailed feedback with time constraints and ensuring that feedback met students' specific needs.

edTPA rubric #15 Using Assessment to Inform Instruction

We emphasized strategies to enhance conceptual understanding and procedural fluency, such as guiding students in interpreting statistical data, managing time, or creating effective graphs. Common approaches included scaffolding and targeted examples to bridge gaps in understanding and connect learning to real-world applications. However, we noted areas for improvement, such as the need for differentiated next steps tailored to varying student levels, opportunities for more advanced challenges, or deeper integration of technological concepts. To achieve a higher level of alignment with edTPA standards, we will have to explicitly link the next steps to research-based practices and provide actionable, individualized recommendations that address both cognitive and motivational needs.

Limitations and Future Works

Our evaluation paper has three major limitations. First, the BSEE curriculum was implemented in only one high school class. A limited scope restricts the generalizability of the findings and insights drawn from the curriculum. To address such a limitation, future work will focus on creating another version of the BSEE curriculum localized to a different cultural and educational context. Additionally, implementing the curriculum in multiple schools and across varied student populations will enable the collection of broader datasets. Such datasets can support iterative revisions and improvements to enhance the effectiveness and adaptability of the BSEE curriculum.

Another limitation of the BSEE curriculum was the team-teaching model used during its implementation. Each team member's unique teaching style introduced variability in instructional delivery, and the lack of a pre-established rapport between the four instructors and the students may have impacted student engagement and learning outcomes. To mitigate such issues, future iterations of the curriculum should focus on integrating it into the actual course taught by regular STEM teachers. Furthermore, providing professional development opportunities for STEM educators will equip them with the necessary skills and resources to implement the BSEE curriculum effectively and consistently.

Lastly, the evaluation of the BSEE curriculum was limited to self and peer assessments because no data were collected directly from the students. Such a decision was intentional, given that this was the first exposure of these students to an integrated STEM curriculum. Our team also sought to avoid adding additional workload, such as completing surveys or participating in interviews. However, collecting feedback from students about their learning experiences will be critical in future iterations. Incorporating new evaluation data, such as surveys or focus groups, will provide valuable insights into their engagement, understanding, and perceptions of the curriculum. Such insights will thereby allow more comprehensive assessments and targeted improvements of the curriculum.

Conclusion

In conclusion, this study provides a comprehensive evaluation of the BSEE curriculum, highlighting its potential to enhance interdisciplinary STEM education at the pre-college level. The curriculum effectively integrates biology, statistics, Excel skills, and engineering, offering students a practical framework to address real-world challenges, such as deer mortality management. Our findings indicate that the BSEE curriculum not only fosters student engagement and understanding of STEM concepts but also underscores the importance of educator preparation in delivering integrated STEM education. The use of iSTEM and edTPA rubrics in our evaluation process has revealed both strengths and areas for improvement, particularly in providing actionable feedback and aligning instruction with diverse student needs.

While the curriculum's implementation in a single classroom by the four undergraduate and graduate students limits the generalizability of our results, the insights gained offer valuable guidance for future curriculum development and educator training. By addressing the identified limitations and expanding the curriculum's application across varied educational contexts, we aim to contribute to the broader discourse on effective STEM education practices. Ultimately, this study affirms the BSEE curriculum's role in preparing students for 21st-century challenges and highlights the critical role of educators in facilitating meaningful STEM learning experiences.

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Appendix 1. Detailed plan of the entire BSEE curriculum

<table>
<tr><th colspan="3">Lesson 1</th></tr>
<tr><th>Time [min]</th><th>Learning Objective</th><th>Detailed Plan</th></tr>
<tr><td>5</td><td>Engage: Students will interpret deer mortality's real-world implications by discussing their experiences or observations related to deer populations and vehicle collisions.</td><td>[Guidance] Have students sit in four groups.
[Interaction] Ice-braking
● Ask students, “Have you or anyone you know ever encountered deer while driving?” “How often do you think deer and cars collide in our area?”
[Lecture] Simplified Learning Objective
○ Analyze deer mortality data from XYZ County by
(1) applying key biological concepts
(2) applying mathematical formulas
[Lecture] Narrow Down
● Population (new) = Population (now) + Births − Deaths + Immigration − Emigration − Predation
● Mortality rate: Natural death and death by human factors
● Emphasize that today, we will focus on mortality derived from human factors.</td></tr>
<tr><td>15</td><td>Explore: Students will exploratorily analyze deer mortality data from XYZ County and apply key biological concepts (e.g., buck harvest, doe harvest, deer-vehicle collisions) to identify</td><td>[Think-Pair-Share] Explore the data
● Students will work in groups for a total of 15 minutes: Think 1 min, Pair 9 min, Share 5 min
● Give each group a portion of the deer mortality data (years 2007-2022).
● Have students check the summary of key terms in the given data, like buck harvest, doe harvest, and deer-vehicle collisions. Explain each term briefly and have students see the back of the index cards.
● Explain the meaning of the total mortality in the data.
Total Mortality = Buck Harvest
+ Doe Harvest
+ Deer-Vehicle Collisions
+ Deer Damage Permits
● Students will explore data to find patterns in buck harvest, doe harvest, deer-vehicle collisions, and total mortality. There will be two guiding questions:
○ “What trends do you observe in the buck and doe harvest data over time? Are there particular years where the number of deer harvested increased or decreased</td></tr>
</table>

<table>
<tr>
<td></td>
<td>patterns and discuss how various factors affect deer populations.

Explain: Students will interpret the calculated mortality, summarize key biological concepts, and connect them to the data students explored.</td>
<td>significantly?”
◦ “How do the deer-vehicle collisions compare to the buck and doe harvest? Are there any years where vehicle collisions were unusually high or low compared to harvest numbers?”
• Emphasize that they need to write down short notes on the end column of the table.
• When students share their answers with the class, encourage them to elaborate on their responses.
• When students share their findings, type down their answers on the shared screen.
<table>
<tr><th>Year</th><th>Buck Harvest</th><th>Doe Harvest</th><th>Deer Vehicle Collision</th><th>Damage Permit</th><th>Total Mortality</th><th>Memo</th></tr>
<tr><td>2007</td><td>742</td><td>575</td><td>408</td><td>0</td><td>1,725</td><td></td></tr>
<tr><td>2008</td><td>640</td><td>509</td><td>411</td><td>0</td><td>1,560</td><td></td></tr>
<tr><td>2009</td><td>757</td><td>713</td><td>405</td><td>0</td><td>1,875</td><td></td></tr>
<tr><td>2010</td><td>765</td><td>649</td><td>388</td><td>0</td><td>1,802</td><td></td></tr>
<tr><td>2011</td><td>735</td><td>587</td><td>362</td><td>0</td><td>1,684</td><td></td></tr>
<tr><td>2012</td><td>643</td><td>798</td><td>323</td><td>0</td><td>1,764</td><td></td></tr>
<tr><td>2013</td><td>597</td><td>728</td><td>354</td><td>0</td><td>1,679</td><td></td></tr>
<tr><td>2014</td><td>568</td><td>610</td><td>313</td><td>0</td><td>1,491</td><td></td></tr>
<tr><td>2015</td><td>468</td><td>468</td><td>317</td><td>0</td><td>1,253</td><td></td></tr>
<tr><td>2016</td><td>518</td><td>379</td><td>283</td><td>6</td><td>1,186</td><td></td></tr>
<tr><td>2017</td><td>412</td><td>343</td><td>312</td><td>7</td><td>1,074</td><td></td></tr>
<tr><td>2018</td><td>478</td><td>385</td><td>312</td><td>1</td><td>1,176</td><td></td></tr>
<tr><td>2019</td><td>517</td><td>400</td><td>310</td><td>12</td><td>1,239</td><td></td></tr>
<tr><td>2020</td><td>645</td><td>502</td><td>335</td><td>4</td><td>1,486</td><td></td></tr>
<tr><td>2021</td><td>580</td><td>429</td><td>365</td><td>0</td><td>1,374</td><td></td></tr>
<tr><td>2022</td><td>644</td><td>524</td><td>388</td><td>0</td><td>1,556</td><td></td></tr>
</table>
</td>
</tr>
<tr>
<td>15</td>
<td>Engineer: Students will calculate total deer mortality for specific years using real-world data by applying mathematical formulas to quantify population changes.</td>
<td>[Introduction]
• “Data can be interpreted differently depending on stakeholders’ interests. To understand such differences in data interpretation, each group will be assigned different roles and see how each group can view the same data differently.”
[Think-Pair] Problem-Solving
• “Write down your group’s answers in Google Slide.”
<Insurance Company Staff>
• Goal: Decrease mortality from vehicle-deer collisions.
• Question 1: Assuming there’s no drastic change, calculate the expected number of deer-vehicle collisions in 2023 based on the average annual increase in collisions from 2019 to 2022. You don’t have to come up with an accurate answer - focus on thinking logically and justifying your calculation.
• Question 2: “If an insurance program in 2023 aims to reduce collisions by 15%, calculate the expected number of collisions for 2023 based on the 2022 data.”</td>
</tr>
</table>

		○ Solution: 388*(1-0.15)=329.8 ● Question 3: “If this reduction trend continued for the next five years, how do you think it would impact insurance claims and costs associated with deer-vehicle collisions? What other measures might further reduce these collisions?” <Farmer> ● Goal: Decrease overall deer population by increasing the total deer harvest. ● Question 1: Assuming there’s no drastic change, calculate the expected number of total deer harvests in 2023 based on the average annual increase in collisions from 2019 to 2022. You don’t have to come up with an accurate answer - focus on thinking logically and justifying your calculation. ● Question 2: “Suppose the farmer coalition advocates for a 25% increase in both buck and doe harvests next year. Calculate the new expected total harvest for 2023 based on the 2022 data.” ○ Solution: 1168*(1+0.25)=1460 ● Question 3: “How might a substantial increase in deer harvest over the next five years affect other wildlife populations or agricultural environments? Could there be unintended consequences of a consistently high harvest?” <Hunter> ● Goal: Increase the number of bucks harvested while lowering doe harvest. ● Question 1: Assuming there’s no drastic change, calculate the expected number of total deer harvests in 2023 based on the average annual increase in collisions from 2019 to 2022. You don’t have to come up with an accurate answer - focus on thinking logically and justifying your calculation. ● Question 2: “After 2022, if hunting regulations increase the buck harvest by 20% while decreasing the doe harvest by 15%, calculate the new expected buck and doe harvest totals for 2023.” ○ 644*(1+0.20)+524*(1-0.15) = 1218 ● Question 3. “What impact might increasing the buck harvest and decreasing the doe harvest have on the future population structure of the deer population (e.g., age distribution, reproductive rates)? Could this approach lead to a sustainable harvest long-term?” <Biologist> ● Goal: Maintain ecosystem balance by keeping fluctuations minimal across all factors. ● Question 1. Assuming there’s no drastic change, calculate the expected number of total deer

<table>
<tr><td></td><td></td><td>mortality in 2023 based on the average annual increase in collisions from 2019 to 2022. You don't have to come up with an accurate answer - focus on thinking logically and justifying your calculation.

Question 2. “Analyze the doe harvest, buck harvest, and vehicle collisions over the years 2019, 2020, and 2021. Calculate the average for each factor. Then, based on your averages, suggest target values for 2022 to keep fluctuations minimal.”

Doe: (400+502+429)/3 = 444
Buck: (517+645+580)/3 = 581
Vehicle: (310+335+365)/3 = 337

Question 3. “How might consistently maintaining these target values affect the deer population's long-term health and ecosystem balance? What are potential risks if one of these factors (e.g., vehicle collisions) suddenly increases or decreases?”
</td></tr>
<tr><td>10</td><td>Evaluation: Results of students' problem-solving and their communication skills</td><td>[Share and Evaluate]

Have each group present their solutions in order.

For question 1, all groups share the answer in order.
For question 2, all groups share the answer in order.
For question 3, all groups share the answer in order.

“Each group has focused on different aspects of the same data. The insurance group focused on car-deer collision data because the increase in collisions means they will likely spend more money on their customers. On the other hand, the farmer group and the hunter group focused on deer harvest data but slightly differently. Farmers will likely want to increase the deer harvest generally, while hunters will likely want to keep hunting regularly. Meanwhile, the biologist group focused on the balance in the deer mortality data because they want the ecosystem to maintain stability.”
Guide students in the next part of the class, where they will use Excel to efficiently analyze deer mortality, which will make big data analysis feasible.
</td></tr>
<tr><td colspan="3" align="center">Lesson 2</td></tr>
<tr><td>5</td><td>Engage: Students will explore how different career</td><td>[Introduction]

Begin with a class discussion on how different careers, like insurance, farming, hunting, and biology, might approach deer mortality.
Connect the lesson to students' prior experiences:

Introduce the real-world problem (deer mortality) to engage students.

</td></tr>
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<table>
<tr><td></td><td>perspectives influence the analysis and interpretation of deer mortality data.</td><td>Relate the issue to the broader concept of wildlife management and public safety.
Present the deer mortality dataset and explain its significance in understanding patterns that inform professional decisions.
Set the context for why data analysis is necessary for decision-making.
Pose the question: How can data analysis help each career address deer mortality issues?</td></tr>
<tr><td>10</td><td>Explore:
Students will organize and select the dataset and calculate descriptive statistics and yearly percentage change using Excel.

Students will reinforce their understanding of data organization and basic statistics.</td><td>[Data Entry and Basic Calculations]
Provide students with the deer mortality dataset in raw format.
Have each group download data from Excel (share hardcopy as well) and calculate the mean, median, range, standard deviation, and yearly percentage change for their assigned focus area (e.g., vehicle collisions for insurance, doe/buck harvest for hunters).
Encourage each group to observe patterns and trends in the data that relate to their professional roles.
Discuss how mean, median, mode, range, and standard deviation help summarize the data.
Utilize paired work for students who need extra support and provide additional practice datasets.
[Worksheet]
<u>Part 1: Data in Excel</u>
Open Excel: Open the deer mortality dataset provided in Excel.
Identify Relevant Columns: Locate the column(s) in the dataset that focuses on Total Mortality.
[Rubrics for Assessment]
Excellent (4) All data entries and calculations are completed accurately for mean, median, range, standard deviation, and yearly percentage change.
Proficient (3) Most data entries and calculations are correct; minor errors that do not affect overall analysis.
Developing (2) Several errors in data entry or calculations, affecting interpretation of results.
Beginning (1) Significant errors or missing calculations prevent accurate analysis.</td></tr>
</table>

10	**Explain:**
	Students will **explain** the relevance of each statistical measure and how they provide insight into the data.
	
	Students will **describe** how the insights into deer mortality supports career-specific decisions.
		[Descriptive Statistics Calculation]
		● Demonstrate step-by-step how to use Excel formulas to calculate the mean, median, range, standard deviation, and yearly percentage change.
		● Discuss the meanings of each statistics.
		    ○ For example, the mean as the average population, the range as the variability in population over time, the standard deviation as an indicator of variability in collision rates for the insurance team or how the mean doe-to-buck ratio helps hunters balance population growth, and the yearly percentage change as how much the data increases or decreases from one year to the next.
		● Allow students to understand how most deer populations cluster around the mean and how extreme values (like unusually high or low populations) are less likely.
		● Engage students in discussions on how these statistics relate to potential periods of increased or decreased deer-vehicle collisions, fluctuations in harvest needs for farmers, sustainable hunting practices for hunters to maintain population balance, and ecosystem stability for biologists in managing population health.
		    ○ Emphasize that problem-solving, data-driven decision-making, and collaboration are essential for addressing real-world challenges in professional contexts
		    ○ Ensure students understand the purpose of calculating these statistics
		[Worksheet]
		<u>Part 2: Calculating Descriptive Statistics</u>
		Calculate each statistic using the following steps, and place the result in a separate cell or a designated “Results” column.
		
		Mean (Average):
		Click on an empty cell where you want the mean result.
		Type the formula: =AVERAGE(CellRange), where CellRange is the column with your data (e.g., G2:G10).
		Mean (2007 - 2014): ___________
		Mean (2015 - 2022): __________
		
		Median:
		Click on an empty cell and type: =MEDIAN(CellRange).

		Median (2007 - 2014): ____________ Median (2015 - 2022): ___________ Range: In two separate cells, calculate the maximum and minimum values: Maximum: =MAX(CellRange) Minimum: =MIN(CellRange) Calculate the range by typing: =MAX(CellRange) - MIN(CellRange). Range (2007 - 2014): ____________ Range (2015 - 2022): ___________ Standard Deviation(SD): Click on an empty cell and type: =STDEV(CellRange). SD (2007 - 2014): ____________ SD (2015 - 2022): ___________ Yearly Percentage Change: In a new column (e.g., "% Change"), calculate the yearly change for each row after the first year: Formula: =(Current Year - Previous Year) / Previous Year * 100. Example: =(G3-G2)/G2*100, eg. if G holds Total Mortality. Drag the formula down the column to apply it to all years.
15	**Engineer:** Students will **research** the various careers and use the calculated statistics to interpret the data and	[Data Interpretation] ● Guide students to interpret the descriptive statistics. ○ What do the numbers reveal about mortality data and its potential impact on their chosen career path? ● Have each group begin by researching their assigned profession's approach to managing deer mortality and population trends. ○ Students will explore real-world challenges and responsibilities within their careers, such as insurance staff evaluating the economic and safety impacts of deer-vehicle collisions or biologists examining the effects of population fluctuations on ecosystem health.

	suggest potential real-world applications. Students will **explore** how the data informs decision-making for addressing deer mortality issues.	● Once each group has a foundational understanding of their profession's role, they will use their calculated statistics to interpret the data through this career-specific lens. ○ For example, insurance staff might identify how collision rates relate to peak deer activity periods and propose targeted interventions like increased road signage or wildlife crossings in high-risk areas, etc. ● Show students how to think about data for further visual representations (bar charts, histograms) of their data using Excel's charting tools. ● Discuss how these interpretations can lead to data visualization and aid in decision-making. [Worksheet] Part 3: Research and Interpretation Goal: Research on how professionals in your assigned career would respond to the patterns and trends you have observed in the data. Conduct Career-Specific Research: Use class resources or external research to understand your career's approach to deer population management. Interpret the Data with Your Research: Based on your research, write a short interpretation for each statistic calculated. Example: If you're assigned the insurance role and see a high standard deviation in collision data, consider how you would explain this in terms of fluctuating road safety risks and the need for targeted interventions. [Rubrics for Assessment] ● Excellent (4) Each statistic is interpreted with depth and clarity, demonstrating a strong understanding of its relevance to the career. ● Proficient (3) Most statistics are interpreted correctly, showing an understanding of the career perspective. ● Developing (2) Limited or unclear interpretation of statistics; some misalignment with career. ● Beginning (1) Lacks interpretation or misinterprets statistics significantly.

5	**Evaluate:** Students will **present** their data analysis and discuss how their findings could inform strategies related to their careers.	[Student Presentations, summarizing, and Reflection] ● Students work in small groups to prepare a brief presentation of their analysis. ○ Each group will describe their deer population data, summarize their descriptive statistics, and explain what these statistics tell us about the population's potential impact based on their career choices. ● Groups will then integrate their research findings and statistical interpretations into a proposal. ○ This proposal will outline strategies tailored to their career goals, explaining how these recommendations respond to the specific patterns and trends identified in the data. ● Through this process, students gain experience in using data analysis to inform real-world decisions in a variety of professional contexts. Following presentations, engage in a class-wide discussion on how data analysis helped inform decisions. [Worksheet] <u>Part 4: Proposal Development</u> Goal: Write a proposal that uses both your statistical interpretations and research findings. Outline the Problem: Briefly describe the deer mortality issue as it relates to your assigned career. Present Data-Driven Insights: Summarize the key trends and patterns found in your statistics Explain how these statistics inform potential risks or opportunities in your career role. Propose a Strategy: Based on the data and your career's approach, suggest actionable recommendations. Support with Data: Use the calculated statistics to justify your recommendations, showing how the data supports your decision. [Rubrics for Assessment] Research and Application to Career ● Excellent (4) Career research is thorough, relevant, and directly applied to data trends, supporting interpretations effectively. ● Proficient (3) Research is relevant and applied to data interpretations, though may lack

		some depth. ● Developing (2) Minimal research with weak application to career perspective in data interpretations. ● Beginning (1) Research is missing or irrelevant to the data and career perspective. Proposal Development ● Excellent (4) Proposal is comprehensive, well-structured, and strongly supported by data, showing clear, career-based solutions. ● Proficient (3) Proposal is well-structured, aligns with data findings, and includes career-based solutions. ● Developing (2) Proposal lacks coherence or sufficient support from data; limited career relevance. ● Beginning (1) Proposal is incomplete or lacks alignment with data and career focus.
Lesson 3		
5	**Engage:** Students will **engage** with the topic by **discuss**ing their personal experiences with graphs, and **identify**ing different types of graphs used in data representation.	● Begin the lesson by reminding the students that they are using a dataset of local deer mortality data and provide a brief recap of the prior lesson. ● Set the context for what the students will be learning throughout the lesson by highlighting its connection to real-world applications. ● Ask the students about their experiences using graphs in their everyday lives at school, work, or home, encouraging them to share examples. ● Capture students' interest in the topic by fostering connections between the lesson content and their daily experiences. ● Facilitate a discussion about the types of graphs students mention, and guide them in identifying graph types (e.g., bar, line, pie).
7	**Explore:**	● Build upon prior student knowledge while developing new understandings related to the topic through student-centered explorations. ● Show the presentation that discusses good and bad aspects of graphs and charts.

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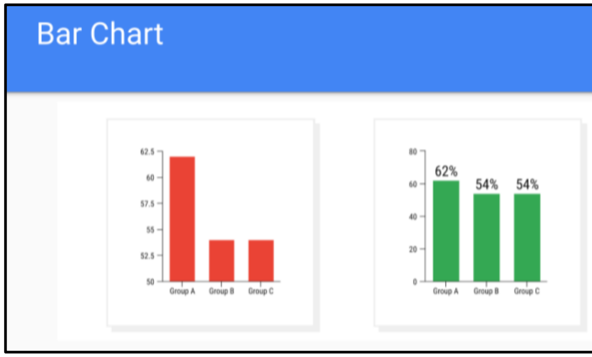

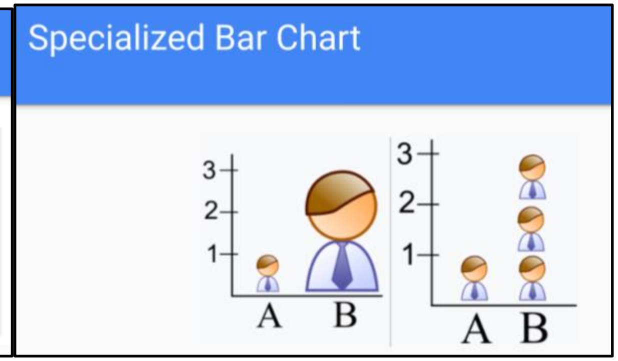

Ask the students about what attributes of the different graphs make them effective and which aspects make them confusing or misleading.
</td>
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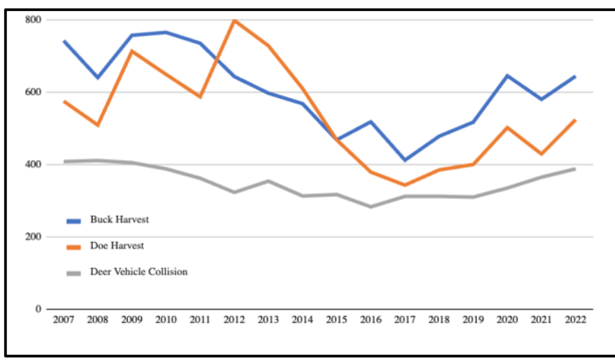
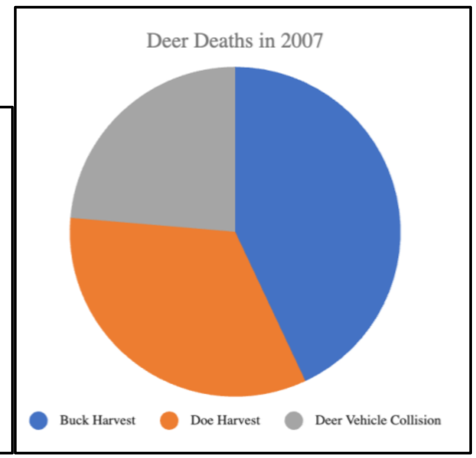
<tr>
<td>15</td>
<td>Explain: Students will summarize new and prior knowledge while addressing potential misconceptions the students may hold.</td>
<td>
Demonstrate how to create a pie chart, a line chart with one line, and a line chart with two lines using the deer mortality dataset.
Engage the students' critical thinking skills by asking them to predict the next steps in creating the graphs.




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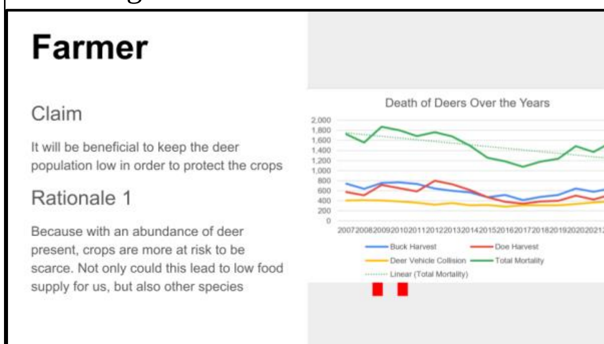
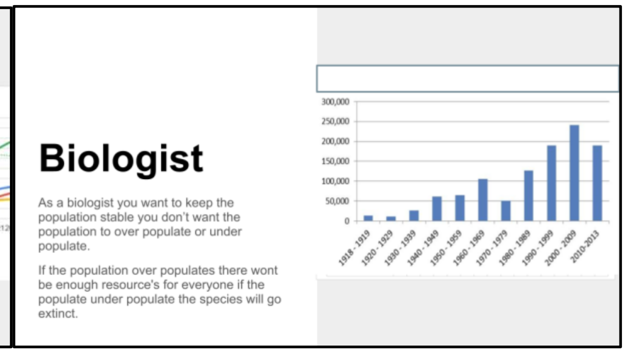
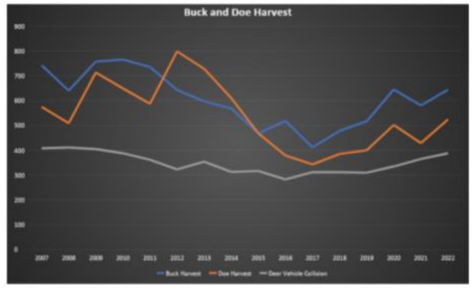
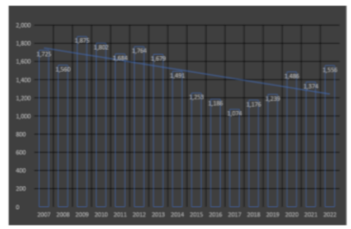
<tr><td>13</td><td>Engineer: Students will engineer a data-driven graph relevant to their assigned profession and refine their design.</td><td>Guide students to apply their knowledge and skills using the engineering design or scientific inquiry process to identify a problem and develop, make, evaluate, or refine a viable solution.
Instruct students to use their newly gained knowledge of creating graphs to design one graph that specifically relates to the profession assigned to them at the beginning of the unit.
Provide specific examples, such as insurance salespeople creating graphs related to car collision mortality, to help students contextualize their work.
Facilitate the activity as an individual task by walking around the classroom to offer support and answer questions.
Encourage students to adopt an engineering design mindset by reflecting on the effectiveness of their graph and identifying areas for improvement.
Differentiate the activity by encouraging students who finish quickly to add more data points or enhance the detail in their graphs.</td></tr>
<tr><td>5</td><td>Evaluate: Students will evaluate the quality and effectiveness of their data visualizations in collaborative group discussions.</td><td>Guide students to evaluate their learning and skill development by comparing their graphs within their assigned groups.
Facilitate group discussions where students analyze the differences and similarities between their graphs and identify ways to improve them.
Lead a class-wide discussion following group presentations to connect the visualizations shared by the groups to real-world careers.
Encourage students to reflect on how their graphs align with professional contexts, such as data analysis in insurance, biology, or engineering.
Direct students to submit their finalized graphs to the teacher’s LMS for evaluation and feedback.</td></tr>
<tr><td colspan="3">Lesson 4</td></tr>
<tr><td>5</td><td>Engage: Students will consider how data can be a powerful tool for persuasion.</td><td>Begin with an overview of how XYZ state manages deer populations by presenting relevant data and justifications.
Ask guiding questions like:
"What is XYZ state doing to control the deer population?"
"What data are they using to support their efforts?"
"How are they convincing the public about the effectiveness of their approach?"</td></tr>
</table>

		● Link this to the lesson's focus and encourage students to consider how data can be a powerful tool for persuasion.
15	**Explore:** Students will construct evidence-based arguments by analyzing and interpreting data visualizations and applying mathematical reasoning to support their assigned professional perspectives	● Direct students to work in small teams, each representing a different profession (hunter, insurance company employee, farmer, and biologist). ● Teacher let students use their mathematical interpretation skills (from Lesson 2) and the data visualizations (Lesson 3) they created to develop arguments supporting their professional stance. ● Remind students that arguments should be objective, data-based, and relevant to their assigned roles. Provide sentence frames or templates as needed to help structure their arguments. 
15	**Engineer** Present argumentation (including solution) and Convince Other Teams(Presentation/Sharing)	● Each team presents their argument to the class, aiming to persuade others from different professional perspectives. ● Encourage teams to critically evaluate one another's arguments, offering constructive feedback and considering the validity of data-based claims. ● Facilitate a brief discussion after each presentation, guiding students to reflect on how data supports different perspectives and why each profession values certain data points.

		Hunter • Doe hunting laws should be tightened. • With tighter Doe Hunting laws the amount of Doe harvest will go down and the Buck harvest will go up because of the increase in birthrates.  **Farmer** • Proposition: It would be rather beneficial if the dear mortality rate had increased • Justification: The increase in deer mortality would mean less of our crops get eaten, and if it decreases more of our crops get eaten. 
5	**Explain:** Students will summarize how data can be used to support their arguments.	• Conclude the lesson by explaining how data is used in real-world settings for persuasion and decision-making. • Reinforce why data analysis was a focus in previous lessons and its importance for future problem-solving skills.